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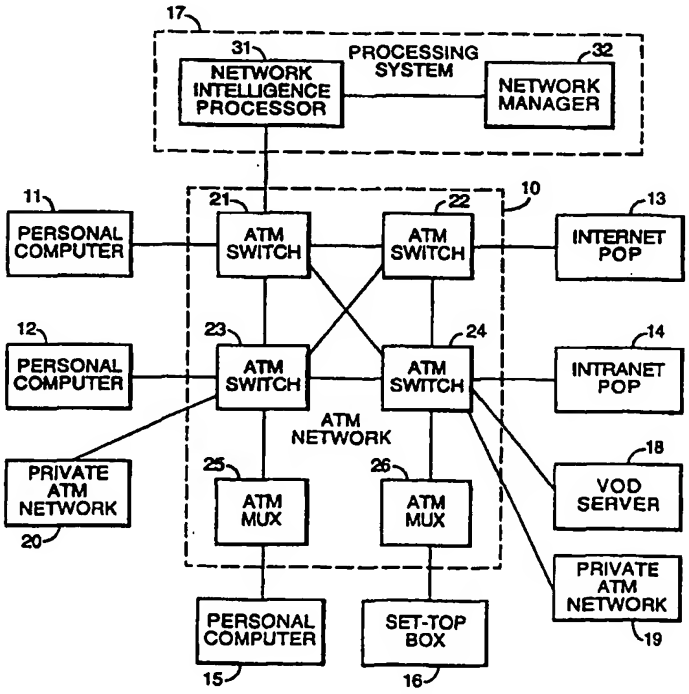
(57) Abstract

There is described a method of establishing a virtual circuit through an ATM network (10) between a calling terminal, for example computer (11), and a destination terminal, for example Internet point of presence (13). In order to establish the virtual circuit, the calling terminal sends a message through the network (10) to a network intelligence processor (31) requesting a list of available destination terminals. The network intelligence processor (31) returns a list of available destination terminals to the calling terminal. At the calling terminal, the user selects a destination terminal and a message containing the selection is transmitted back to the network intelligence processor (31). The network intelligence processor (31) then establishes the network addresses of the calling terminal and the selected destination terminal. It passes these network addresses to a network manager (32). The network manager (32) then sends the routing information required to establih the virtual circuit to the switches and multiplexers of the ATM circuit (10).



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# METHOD AND SYSTEM FOR ESTABLISHING A VIRTUAL CIRCUIT THROUGH A PACKET SWITCHED NETWORK

This invention relates to a method of establishing a virtual circuit between a calling terminal and a destination terminal through a packet switched network and also to a processing system for establishing such a circuit.

In a known method of establishing a virtual circuit through a packet switched network between a calling terminal and a destination terminal, the user of the calling terminal supplies details of the destination terminal to a network management operator. The network management operator then establishes whether a virtual circuit can be provided between the calling terminal and the requested destination terminal. For example, if the network management operator decides that the virtual circuit cannot be provided, he advises the user of the calling terminal accordingly. It might not be possible to provide the virtual circuit, for example, where the destination terminal is a private intranet or a local area network to which the user is denied access. There could also be technical reasons which make it impossible to establish the requested virtual circuit. If the network management operator decides that it is possible to establish a requested virtual circuit, he inputs details of the calling terminal and the destination terminal into a network manager. The network manager then establishes the requested virtual circuit. In this specification, the term "network manager" refers to equipment which is arranged to perform network management operations. This method of establishing a virtual circuit is inefficient because it involves the use of network management personnel.

According to one aspect of this invention there is provided a method of establishing a virtual circuit between a calling terminal and a destination terminal through a packet switched network, said method comprising the steps of:

transmitting a request for a list of destination terminals from a calling terminal through said network to a processing system connected to said network;

returning a list of destination terminals from said processing system through said network to the calling terminal;

transmitting an indication of a selected destination terminal from said calling terminal through said network to the processing system; and

said processing system establishing a virtual circuit between the calling terminal and the selected destination terminal.

This invention provides the advantage that a virtual circuit can be established through a packet switched network without involving network management personnel.

Preferably, said step of establishing a virtual circuit between the calling terminal and the selected destination terminal comprises the steps of establishing the network addresses of the calling terminal and the selected destination terminal, and using said network addresses to establish the virtual circuit.

In one embodiment of the invention, in said step of establishing a virtual circuit, a network management protocol is used to establish the virtual circuit. In another embodiment, in said step of establishing a virtual circuit, a signalling protocol is used to establish the virtual circuit.

According to a second aspect of this invention there is provided a processing system for establishing a virtual circuit between a calling terminal and a destination terminal through a packet switched network, said system comprising:

a first component for generating a list of destination terminals; and

a second component for establishing a virtual circuit through said network;

said first component being arranged to supply a list of destination terminals to a calling terminal, to receive an indication of a selected destination terminal from a calling terminal and to supply details of a calling terminal and a selected destination terminal to the second component;

the second component being arranged to use details of a calling terminal and a selected destination table received from the first component to establish a virtual circuit through the network between the calling terminal and the selected destination terminal.

This invention will now be described in more detail, by way of example, with reference to the drawings in which:

Figure 1 is a block diagram of a public ATM network and a set of terminals connected to the public ATM circuit, together with two private ATM networks and a processing system which are also connected to the public ATM network, which illustrate an embodiment of this invention;

Figure 2 is a block diagram illustrating the main components of a computer;

Figure 3 is a block diagram of some of the software components of the network intelligence processor shown in Figure 1;

Figure 4 is a flow chart illustrating the sequence of operations which are performed in setting up a virtual circuit through the ATM network of Figure 1;

Figure 5 shows the software components of a modified form of the network intelligence processor of Figure 1; and

Figure 6 is a flow chart illustrating the sequence of operations which are used to establish a virtual circuit through the ATM network of Figure 1 using the modification illustrated in Figure 5.

Referring now to Figure 1, there are shown a public ATM network 10, a set of terminals 11 to 16 and 18 connected to the network 10 and a processing system 17. Figure 1 also shows a pair of private ATM networks 19, 20 connected to the ATM network 10.

The ATM network itself comprises four fully interconnected switches 21 to 24 and two multiplexer/demultiplexers 25 and 26 connected, respectively, to ATM switches 23 and 24. In the present example, all four switches 21 to 24 function as access switches. The ATM network 10 shown in Figure 1 is a relatively simple ATM network in that it has only four switches, each of which is an access switch. The invention may, of course, be used in an ATM network having a much larger number of switches. In a larger network, some of the access switches may be interconnected by other switches which do not function as access switches.

As is well known, an ATM network is a packet switched network in which individual packets take the form of 53 byte cells. Each cell has a five byte header and a 48 byte payload. In each cell, the header includes routing information in two fields known as the virtual path identifier (VPI) and the virtual channel identifier (VCI) fields. Often, but not necessarily, the VPI field of a cell provides a coarse level routing while the VCI field provides a fine level routing.

As a cell travels between an originating terminal and a destination terminal, the VPI and VCI fields are set to initial values before the cell passes through the ATM input interface. The ATM interface may be, for example, the ATM card in a personal computer. Then, at each switch between the ATM input interface and the ATM output interface, VPI and/or VCI fields are read and an output port is selected in accordance with the value of one or both of these fields

using the routing table contained in the switch. Before forwarding the cell on to the selected output port, the values of one or both of these fields are updated. When a cell passes through a multiplexer/demultilexer in the demultiplexing direction, routing is controlled in a similar manner.

For a particular connection between two terminals, the routing tables are established before call commencement. Consequently, during a call, two terminals are connected by a virtual circuit. As is well known, in a virtual cicuit, cells carrying data can travel from an originating terminal to a destination terminal and also from an destination terminal to an originating terminal.

During call set up of a virtual circuit, the values in the routing tables for the switches and multiplexers used in the virtual circuit and the initial values of the VPI and VCI fields can be established by network management or by signalling processes. Where network management is used, the network manager uses a network management protocol to transmit the initial VPI and VCI fields to the two terminals and also the routing information to the switches and multiplexers which are used in the virtual circuit.

When a virtual circuit is established by using signalling processes, call set up commences with an originating terminal sending a request for the virtual circuit to the network using a user-network signalling protocol. The request is carried in ATM cells between the originating terminal and the network over a signalling virtual channel. Within the network, the virtual circuit is established by signalling messages which use a signalling protocol and pass between the nodes (switches and multiplexers) in ATM cells. Between the network and the destination node, signalling messages which use the user-network signalling protocol are also carried in ATM cells over a signalling virtual channel.

Referring again to Figure 1, the terminals 11, 12 and 15 are personal computers, the terminal 16 is a set-top box for a television set, the terminal 18 is a video-on-demand (VoD) server, the terminal 13 is an Internet point of presence (POP) and the terminal 14 is an intranet POP. The processing system 17 comprises a network intelligence processor 31 and a network manager 32.

There are various possibilities for connecting the personal computer 11 to the ATM switch 21. The connection may be provided by way of a dedicated access line, for example, a twisted copper pair or an optical fibre. Alternatively, the computer 11 may have a dial-up integrated services digital network (ISDN)

connection to the ATM switch 21. As another possibility, the computer 11 may be connected to the ATM switch 21 through a telephone line formed from a twisted copper pair but with the addition of the technology known as asymmetric digital subscriber line (ADSL). As is well known, where an access line uses ADSL technology, electronic devices at each end of the line cooperate to provide a data transmission channel in addition to an ordinary telephone channel. In one version, the data channel can deliver 1.5Mbit/s downstream in addition to 16kbit/s in the upstream direction. These connection possibilities apply also to the personal computers 12 and 15.

As the set-top box 16 is designed to receive video data, the connection between it and the ATM multiplexer 26 must be capable of delivering data at a relatively high bandwidth. Thus, this connection may take the form of an optical fibre or a twisted copper pair provided with ADSL technology.

The connections between the POPs 13, 14 the VoD server 18, the private networks 19, 20, and the network intelligence processor 31 and their associated ATM switches in the public ATM network 10 take the form of high bandwidth dedicated links provided, for example, by optical fibres or coaxial cable.

The network intelligence processor 31 and the network manager 32 may be connected, for example, through a dedicated link or by way of an X25 channel through the public data network.

Although not shown, in order to perform network management operations, the network manager 32 is connected to the ATM switches 21 to 24 and multiplexerdemultiplexers 25 and 26 and these connections may be through the public data network using X25 channels. Alternatively, these connections may be permanent virtual circuits through the ATM network 10.

Each of the personal computers 11, 12 and 15 is of conventional construction and the hardware construction of one of these computers is shown diagrammatically in Figure 2. As shown in Figure 2, the computer comprises a central processing unit (CPU) 40, storage devices 41, a visual display unit (VDU) 42, a keyboard 43 and input/output ports 44. The storage devices 41 are of conventional form and comprise random access memory (RAM), read only memory (ROM), a hard disk and a floppy disk. The software applications which control the computer are stored in the storage devices 41.

The software applications include a communications application which permits the computer to transmit and receive packets using the well known TCP/IP protocols. Thus, the computer can communicate with terminals connected to the public Internet as well as to private intranets. In order to permit the computer to communicate with the ATM network 10, it is provided with an ATM card 45 and an associated software application. The ATM card 45 together with the software application segment outgoing data packets into ATM cells and reassemble incoming ATM cells into IP data packets.

As is well known, in addition to using the TCP/IP protocols, information transfer between Internet clients and servers can also use higher level protocols. In the World Wide Web (or simply Web) service, information is stored as HyperText Mark-up Language (HTML) pages and information is transferred using the HyperText Transfer Protocol (HTTP). An Internet server which can supply information using the Web service is known as a Web server and an Internet client which can access such information is known as a Web client. In order to access information using the Web service, a Web client is provided with a software application known as a Web browser. A Web browser interprets and displays the information which it receives for display on the computer's VDU. A Web browser specifies the information it wishes to retrieve using a Uniform Resource Locator (URL). In each of the computers 11, 12 and 15, the software applications include a Web browser.

The set-top box 16 can be connected to a television set for display of video programmes retrieved by the set-top box 16 from Internet server or VoD servers. The components of the set-top box 16 include a video demodulator unit, a video decompression unit and a video modulator and also a microprocessor for controlling various other components. In addition, the set-top box 16 includes a Web browser as well as the software applications needed to permit it to receive data using the TCP/IP protocols. The Web browser in the set-top box 16 may be a cut-down version of a Web browser suitable for a computer. It also has an ATM card and associated software application.

The POP 13 is configured to permit data transmission between the ATM switch 22 and the public Internet. Similarly, the POP 14 is configured to permit data transmission between the ATM switch 24 and a private intranet.

The VoD server 18 has an ATM card and associated software.

The network intelligence processor 31 is also constructed as an individual computer and has an internal construction as illustrated in Figure 2. It includes an ATM card and an associated application to permit it to send and receive data from the ATM network 10. As shown in Figure 3, the software applications of the network intelligence processor 31 include a Web server 50, an address translator 51 and an interface 52. The interface 52 permits it to communicate with the network manager 32. The function of the address translator will be described below. By way of modification, the network intelligence processor 31 could take the form of a group of individual computers connected together by communication links.

Although the computers 11, 12, 15, the set-top box 16 and the network intelligence processor 31 are equipped to use the Web service, they may alternatively, or in addition, be equipped to use another higher level protocol service. Each of the terminals 11, 12, 15 and 16 is provided with a virtual signalling channel to the network intelligence processor 31. These channels are established by the routing tables in the ATM switches 21 to 24. Each of the terminals 11, 12, 15 and 16 stores the initial VPI and VCI values to access its virtual signalling channel to the network intelligence processor 31.

The network manager 32 is constructed as an individual computer and has a hardware construction as illustrated in Figure 2. The network manager 32 is arranged to perform standard network management operations. These include monitoring the individual ATM switches 21 to 24 and multiplexer/demultiplexers 25 to 26 and controlling traffic overload. The network manager 32 can also establish the routing information needed to provide a virtual circuit and transmit this information to appropriate ones of switches 21 to 24 and multiplexer/demultiplexers 25 and 26.

Many terminals of ATM networks, including terminals 11, 12, 15 and 16, are not equipped to establish virtual circuits with the use of a user-network signalling protocol. In the presently known method of establishing a virtual circuit from such a terminal, the user of the terminal sends details of the required virtual circuit to network management personnel. With the aid of a network manager, the network management personnel then establish the virtual circuit. Because this method involves the use of network management personnel, it is inefficient and not suitable for establishing virtual circuits for short periods.

In the invention, in order to establish a virtual circuit between a calling terminal and a destination terminal, the calling terminal, for example terminal 11, transmits a request to the processing system 17 for a list of destination terminals. The processing system 17 then returns a list of destination terminals to the calling terminal. The user then selects a destination terminal and the calling terminal transmits a message containing the identity of a selected destination terminal back to the processing system 17. The processing system 17 then establishes the required virtual circuit. This method will now be described in more detail with reference to the flow chart shown in Figure 4.

In an initial step 100, when the user of a calling terminal, for example personal computer 11, wishes to establish a virtual circuit to a destination terminal, for example POP 13, the calling terminal sends a request to the network intelligence processor 31 over its signalling virtual circuit for a list of available destination terminals. When doing this, the user enters the Web browser application on the calling terminal and the Web browser application is arranged to display an appropriate icon for establishing a virtual circuit. In the network intelligence processor 31, the request is received by the Web server 50, which passes it to the address translator 51. For each terminal, which might want to establish virtual circuit, the address translator 51 maintains a list of available destination terminals. Each list is stored as a Web page. On receiving the request from the Web server 50, the address translator 51 supplies the list of available destination terminals to the Web server 50 which then transmits this list to the calling terminal. The list also includes transmission options such as quality of service and cell transmission rate.

At the calling terminal, the list is displayed as a Web page. In a step 101, the user selects the required destination terminal and transmission options and the Web page containing the user's selection is returned to the Web server 50 in the network intelligence processor 31. Thus, the returned Web page provides an indication of the destination terminal selected by the user.

In a step 102, the Web server 50 forwards this Web page to the address translator 51. The address translator 51 then establishes the network addresses of the calling terminal and the selected called terminal and forwards this information together with the selected transmission options to the interface 52.

Next, in a step 103, the interface 52 passes the network addresses and the selected transmission options to the network manager 32.

Next, in a step 104, the network manager 32 configures the ATM network 10 to provide the requested virtual circuit. In order to do this, it establishes the routing information needed by the switches and multiplexers and transmits this information to the switches and multiplexers. It also informs the destination terminal that a virtual circuit is being established and sends to the destination terminal the VPI and VCI values which it will have to insert into its ATM cells. While the network manager 32 is establishing the virtual circuit, it transmits status information, as may be appropriate, to the network intelligence processor 31 which forwards this information to the calling terminal.

When the network 10 has been configured to provide the requested virtual circuit, in a step 105 the network manager 32 sends a message to the network intelligence processor 31 confirming this and also the values of the VPI and VCI required by the calling terminal to send ATM cells over the virtual circuit. Finally, in a step 106, the network intelligence processor 31 sends a message containing confirmation that the virtual circuit has been established and the initial VPI and VCI values to the calling terminal.

Referring now to Figure 5, there is shown a modified form of the software applications of the network intelligence processor 31 which is used in a second embodiment of this invention. In this embodiment, the software applications of the network intelligence processor comprise the Web server 50 and the address translator 51 and a proxy signalling agent 120 in place of the interface 52. The proxy signalling agent is a software application on a terminal which is capable of establishing a virtual circuit on behalf of another terminal. In order to do this, the proxy signalling agent uses a user-network signalling protocol.

The steps which are performed to establish a virtual circuit in the second embodiment will now be described with reference to the flow chart shown in Figure 6.

In an initial step 130, the calling terminal, for example personal computer 11, sends a request to the network intelligence processor 31 for a list of available destinations. The list is returned to the personal computer 11, together with transmission options.

Next, in a step 131, the user of the calling terminal selects a destination terminal and the transmission options and a message containing the selection is returned to the network intelligence processor 31.

In a step 132, the address translator 51 establishes the network address of the calling and selected called terminals. Then, in a step 133, the address translator passes the network addresses and the selected transmission options to the proxy signalling agent 120.

In a step 134, the proxy signalling agent 120 sends a request to the network 10 to establish the requested virtual circuit with the selected transmission options.

Using signalling processes within the network 10, the requested virtual circuit is established. In a step 135, the network 10 sends a message to the network intelligence processor 31 confirming that the network has been configured to provide the virtual circuit and giving the initial VPI and VCI values.

Lastly, in a step 136, the network intelligence processor 31 sends a message to the calling terminal which contains confirmation that the virtual circuit has been established and the initial VPI and VCI values required by the calling terminal.

Although this invention has been described with reference to an ATM network, it is to be appreciated that it can also be used in other type of packet switched connection-oriented networks. For example, it could be used in a Frame Relay network.

CLAIMS

1. A method of establishing a virtual circuit between a calling terminal and a destination terminal through a packet switched network (10), characterised in that said method comprises the steps of:

transmitting a request for a list of destination terminals from a calling terminal through said network (10) to a processing system (17) connected to said network;

returning a list of destination terminals from said processing system (17) through said network to the calling terminal;

transmitting an indication of a selected destination terminal from said calling terminal through said network to the processing system (17); and

said processing system (17) establishing a virtual circuit between the calling terminal and the selected destination terminal.

2. A method as claimed in claim 1, in which said step of establishing a virtual circuit between the calling terminal and the selected destination terminal comprises the steps of:

establishing the network addresses of the calling terminal and the selected destination terminal; and

using said network addresses to establish the virtual circuit.

3. A method as claimed in claim 1 or claim 2, in which, in said step of establishing a virtual circuit, a network management protocol is used to establish the virtual circuit.

4. A method as claimed in claim 1 or claim 2, in which, in said step of establishing a virtual circuit, a signalling protocol is used to establish a virtual circuit.

5. A method as claimed in any one of the preceding claims, in which the packet switched network is an asynchronous transfer mode (ATM) network.

6. A processing system (17) for establishing a virtual circuit between a calling terminal and a destination terminal through a packet switched network(10), characterised in that said system comprises:

a first component (31) for generating a list of destination terminals; and

a second component (32) for establishing a virtual circuit through said network;

said first component being arranged to supply a list of destination terminals to a calling terminal, to receive an indication of a selected destination terminal from a calling terminal, and to supply details of a calling terminal and a selected destination terminal to the second component;

the second component being arranged to use details of a calling terminal and a selected destination terminal received from the first component to establish a virtual circuit through the network between the calling terminal and the selected destination terminal.

7. A processing system as claimed in claim 6, in which the first component is arranged to establish the network addresses of a calling terminal and a selected destination terminal and to supply the said network addresses to the second component.

8. A processing system as claimed in claim 6 or claim 7, in which the second component is a network manager (32) which is arranged to use a network management protocol to establish a virtual circuit.

9. A processing system as claimed in claim 6 or claim 7, in which the second component is a signalling agent (120) which is arranged to use a signalling protocol to establish a virtual circuit.

10. A processing system as claimed in any one of claims 6 to 9, in which said network is an asynchronous transfer mode (ATM) network.

Fig.1.

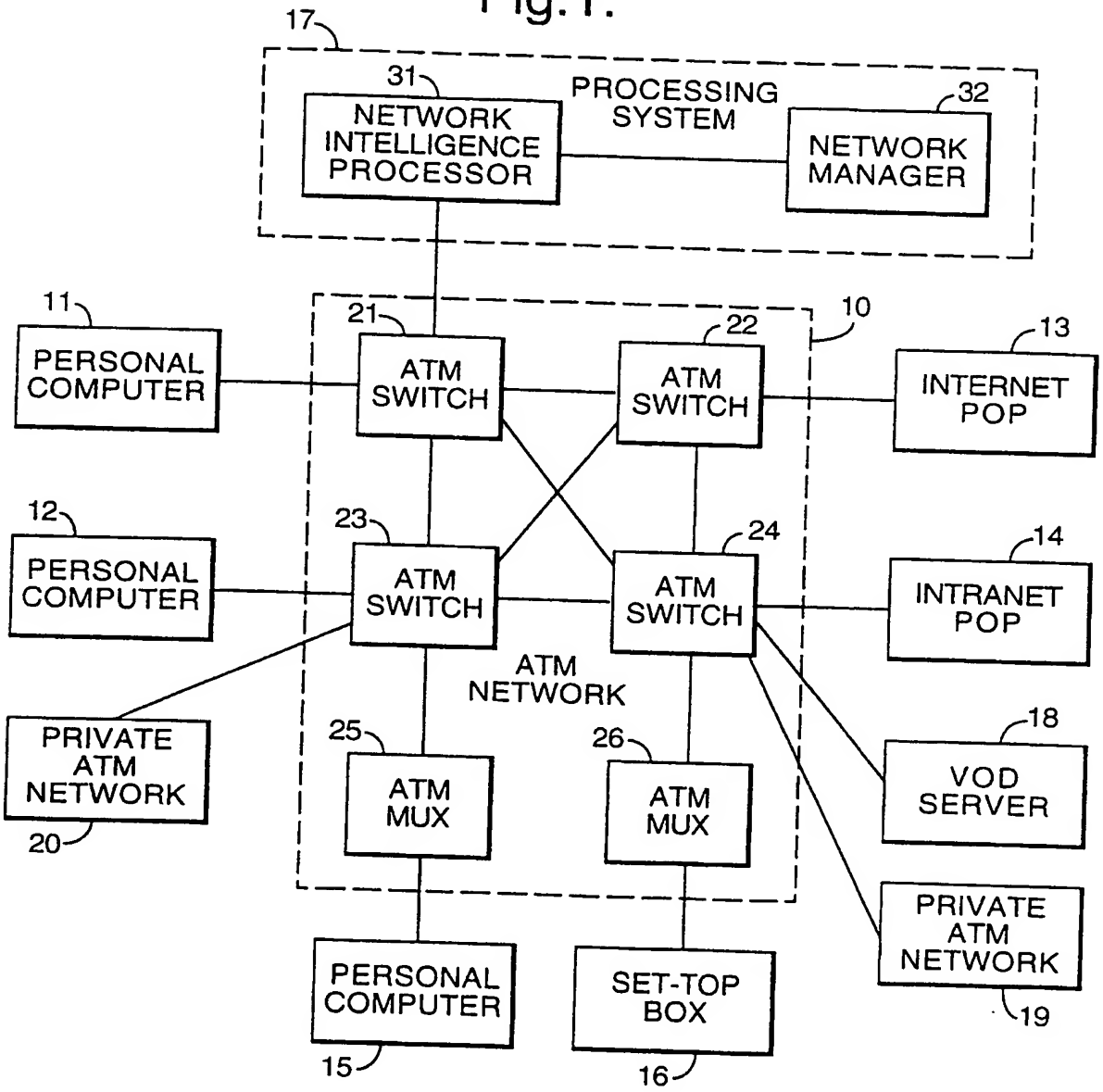

17
31
NETWORK INTELLIGENCE PROCESSOR
PROCESSING SYSTEM
32
NETWORK MANAGER
11
PERSONAL COMPUTER
21
ATM SWITCH
22
ATM SWITCH
10
13
INTERNET POP
12
PERSONAL COMPUTER
23
ATM SWITCH
24
ATM SWITCH
14
INTRANET POP
ATM NETWORK
PRIVATE ATM NETWORK
20
25
ATM MUX
26
ATM MUX
18
VOD SERVER
PRIVATE ATM NETWORK
19
PERSONAL COMPUTER
15
SET-TOP BOX
16

Fig.2.

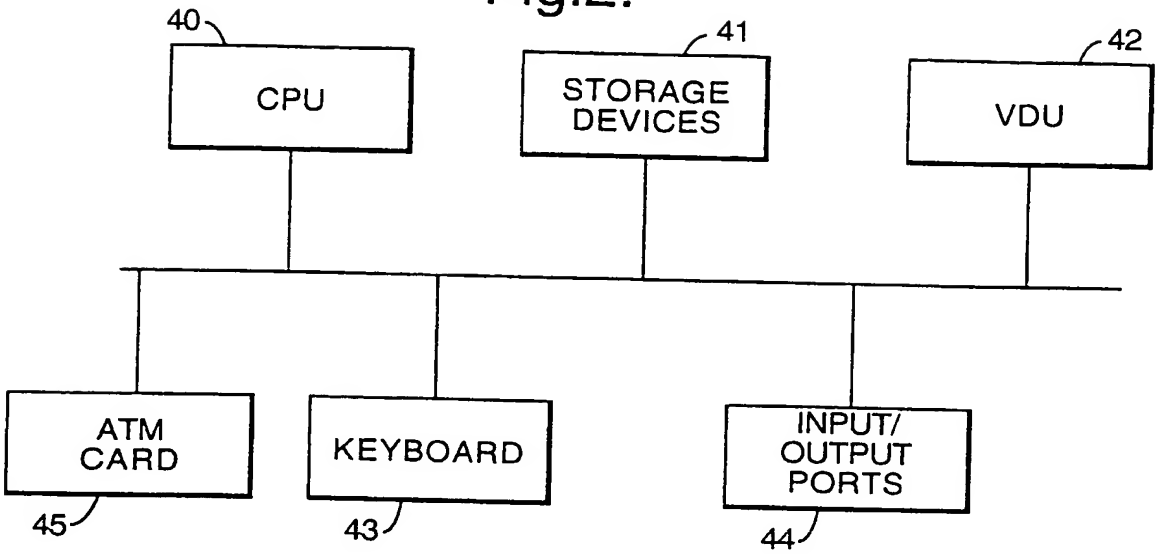

40
CPU
41
STORAGE DEVICES
42
VDU
ATM CARD
45
KEYBOARD
43
INPUT/ OUTPUT PORTS
44

Fig.3.

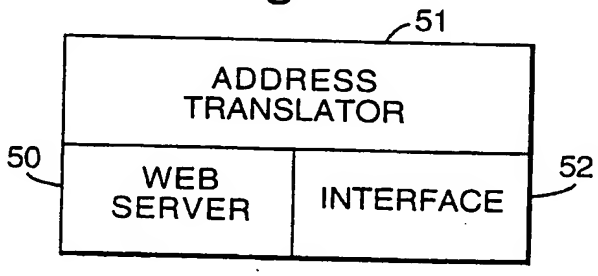

51
ADDRESS TRANSLATOR
50
WEB SERVER
INTERFACE
52

Fig.4A.

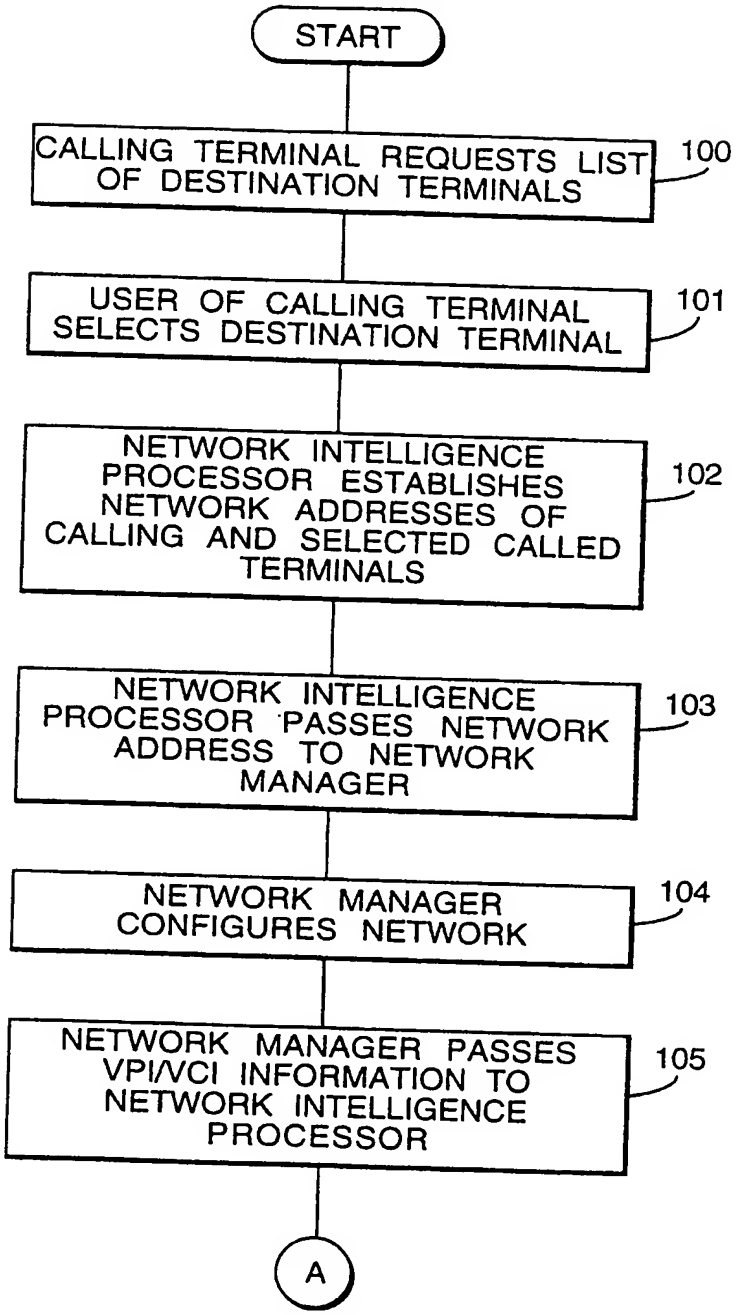

START
CALLING TERMINAL REQUESTS LIST OF DESTINATION TERMINALS
100
USER OF CALLING TERMINAL SELECTS DESTINATION TERMINAL
101
NETWORK INTELLIGENCE PROCESSOR ESTABLISHES NETWORK ADDRESSES OF CALLING AND SELECTED CALLED TERMINALS
102
NETWORK INTELLIGENCE PROCESSOR PASSES NETWORK ADDRESS TO NETWORK MANAGER
103
NETWORK MANAGER CONFIGURES NETWORK
104
NETWORK MANAGER PASSES VPI/VCI INFORMATION TO NETWORK INTELLIGENCE PROCESSOR
105
A

Fig.4B.

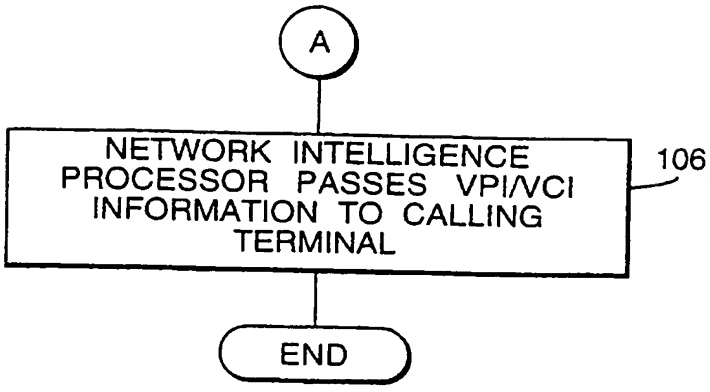



Fig.5.

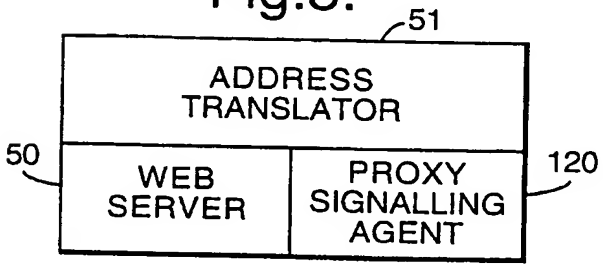



Fig.6B.

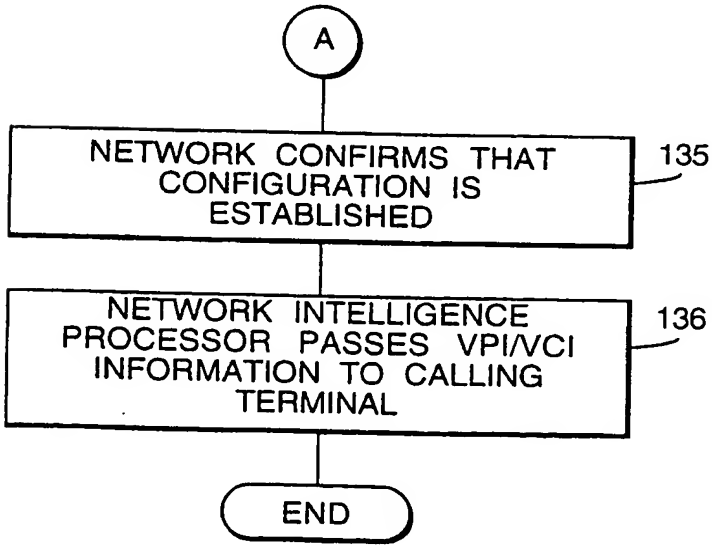
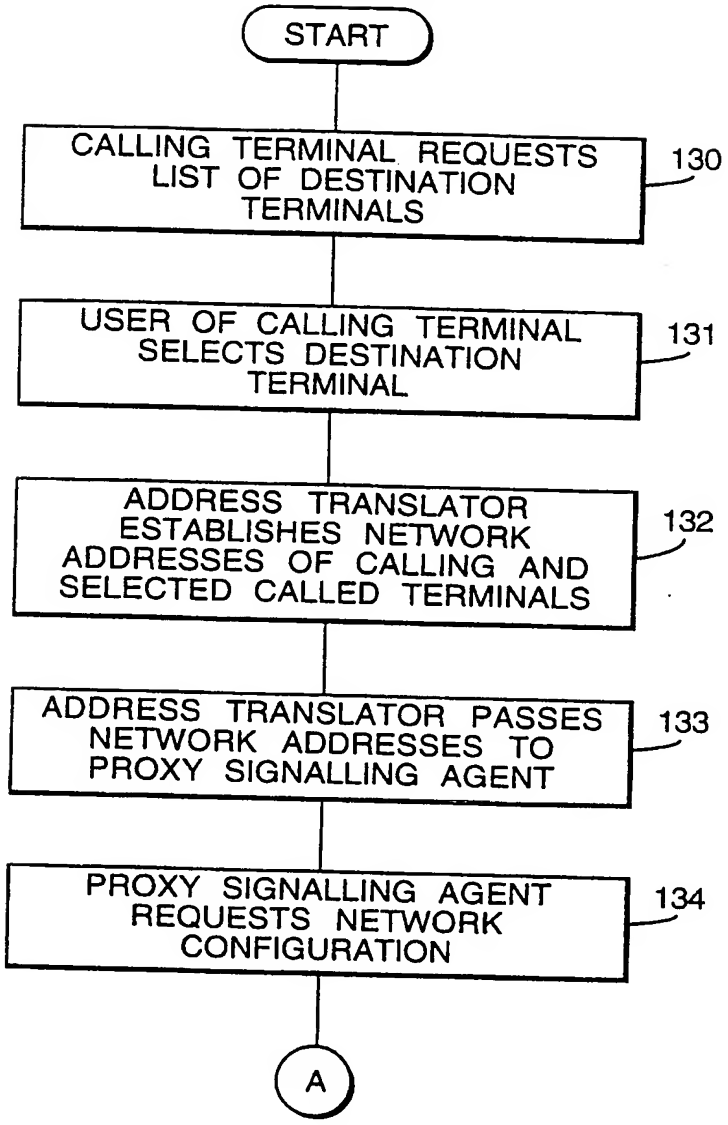


Fig.6A.


START
CALLING TERMINAL REQUESTS LIST OF DESTINATION TERMINALS
130
USER OF CALLING TERMINAL SELECTS DESTINATION TERMINAL
131
ADDRESS TRANSLATOR ESTABLISHES NETWORK ADDRESSES OF CALLING AND SELECTED CALLED TERMINALS
132
ADDRESS TRANSLATOR PASSES NETWORK ADDRESSES TO PROXY SIGNALLING AGENT
133
PROXY SIGNALLING AGENT REQUESTS NETWORK CONFIGURATION
134
A

# INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/GB 99/00364

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04Q11/04 H04L12/66 H04L29/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04Q H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | WO 97 47114 A (KRUY STEVEN J ;LAND MARK S (US); CIGNAL GLOBAL COMMUNICATIONS L (U) 11 December 1997<br>see claim 1; figure 1<br>see page 6, line 12 - page 7, line 11<br>see page 23, line 15 - line 22<br>--- | 1-10 |
| Y | SUZUKI S ET AL: "CALL ROUTING AND DATA MODEL FOR INTER-NETWORK ROAMING IN PCS" IEICE TRANSACTIONS ON COMMUNICATIONS, vol. E79-B, no. 9, September 1996, pages 1371-1379, XP000613293<br>paragraph 2.1.c<br>--- | 1-10 |
| A | US 5 682 325 A (LIGHTFOOT REGINA ET AL) 28 October 1997<br>see claim 1<br>---<br>-/-- | 1-10 |

[X] Further documents are listed in the continuation of box C. [X] Patent family members are listed in annex.

° Special categories of cited documents :

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"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 27 May 1999 | 09/06/1999 |

| Name and mailing address of the ISA | Authorized officer |
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| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Staessen, B |

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# INTERNATIONAL SEARCH REPORT

Int Ional Application No
PCT/GB 99/00364

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication,where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
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| A | ECKARDT T ET AL: "ON THE PERSONAL COMMUNICATIONS IMPACTS ON MULTIMEDIA TELESERVICES"<br>MULTIMEDIA: ADVANCED TELESERVICES AND HIGH-SPEED COMMUNICATION ARCHITECTURES. INTERNATIONAL WORKSHOP,26 September 1994, pages 435-449, XP000613104<br>see paragraph 4 | 1,6 |
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Information on patent family members

Int tional Application No
PCT/GB 99/00364

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
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| | | AU 3475697 A | 05-01-1998 |
| | | EP 0898829 A | 03-03-1999 |
| US 5682325 A | 28-10-1997 | US 5740075 A | 14-04-1998 |
| | | US 5621728 A | 15-04-1997 |
| | | US 5748493 A | 05-05-1998 |